AMENDED APPLICATION FOR THE NATIONAL/REGIONAL PHASE

Description

# Apparatus for fitting substrates with electrical components

The invention relates to an apparatus for fitting substrates with electrical components by means of a moveable fitting head for handling the components, which can be picked up at feed devices by at least one gripper belonging to the fitting head, transported to fitting locations on the substrate and placed onto the substrate there.

A device of this type has been disclosed, for example, by US 4,875,285. A fitting head like a turret head has a large number of grippers constructed as suction pipettes, which pick up the components at the feed devices. From there, the fitting head moves to a printed circuit board which is fixed in the apparatus and onto which the components are placed successively. In this case, the number of components transported is restricted to the number of suction pipettes. After the placement action, the fitting head must be moved again to the feed devices arranged outside the fitting area.

It is particularly the case that large components, for example multi-pin ICs, cannot be handled by the turret head for reasons of space. Provided for such components are heads having only one gripper, with which only one component can be transported in each case.

The invention is based on the object of increasing the fitting performance with a low constructional outlay.

This object is achieved by the invention in accordance with claim 1. The storage element can be designed to be sufficiently large that it is able to accommodate a large number of components. In this case, the fitting head in the area of the feed devices will

pick up components until the storage element has been filled. Then,

the fitting head moves over the substrate to be fitted, where the gripper removes the components from the storage element and places them successively onto the envisaged fitting locations. A fitting head of this type needs only a single gripper for filling and emptying the storage element. Since, in this case, only low relative movements take place between the gripper and the storage element, these operations are able to proceed at a high clock rate, similar to that in the turret head.

In mechanical terms, the storage element can be configured largely more simply than the grippers of the turret head. In addition, it can be kept so large that it accommodates a considerably larger number of components, as a result of which the fitting head has to move less often between the feed devices and the substrate.

Advantageous developments of the invention are identified in claims 2 to 18:

The development as claimed in claim 2 means that the components can be transported between the gripper and the storage element in simple movement sequences.

The pivoting part as claimed in claim 3 means that the relative movement of the gripper between the placement and the transfer position can be implemented in a simple way.

As a result of the development as claimed in claims 4 and 5, the component can be fetched in a simple way from the feed devices, transferred to the storage element, removed from the latter and placed onto the substrate.

As a result of the development as claimed in claim 6, the transfer between the gripper and the storage element can be controlled in such a way that the component is held safely in every phase.

As a result of the development as claimed in claim 7, the action of positioning the components on the sliding part is simplified. It is possible to assign a sensing device, for example an optical sensing device, for determining the position of the components to one of the stepping positions of the sliding part. Since the transferring of the components from the sliding part to the gripper is carried out in a defined manner, it is possible to use the position data obtained from the sensing device to correct the angle and position of the components.

The suction openings as claimed in claim 8 constitute simple holding means for the components on the sliding part.

The developments as claimed in claims 9 and 10 mean that the components can be held and transferred on the sliding part in a simple way.

The annular sliding part as claimed in claim 11 constitutes a structural part which is simple and simple to operate.

The arrangement as claimed in claim 12 readily permits the vertical placement of the components onto the storage spaces or onto the substrate.

As a result of the development as claimed in claim 13, the alternating operations when fetching the components from the feed devices and when filling the storage element can be accelerated, in that in each case one of the grippers is located in the fetch position and another in the transfer position. In the same way, the actions of emptying the storage element and fitting the substrate can be accelerated.

The pivoting part as claimed in claim 14 needs only two grippers, which, in a pendulum-like movement, alternately assume the placement position and the transfer position. In this case, however, each individual gripper must be assigned its own transfer position. In the case of a sliding part which is

concentric with the placement position, this can be implemented in a straightforward manner by the

two transfer stations being located diametrically opposite each other. A filling cycle can then be carried out with half a revolution of the sliding part, each of the two grippers filling one half of the ring.

The rotor as claimed in claim 15 means that the pivoting part can be indexed in a rotational movement without any change of direction. Since, then, the grippers are no longer primarily used for storing the components, their number can be reduced to the number of working stations provided without any costs in terms of performance. If, for example, in addition to the placement station and to the transfer station, a sensing and a rotation station are further provided, only four grippers are then needed.

As a result of the development as claimed in claim 16, the components are transferred at the clock rate of the fitting head without any loss of time.

The arrangement as claimed in claim 17 makes it possible to perform the positional control and position correction of the components following removal from the storage element and directly before the last handling step of the placement onto the substrate.

By means of the additional storage element as claimed in claim 18, the storage capacity can be increased considerably. In the case of a turret-like fitting head, it is easily possible to assign the second transfer station to a previously unused holding station.

In the following text, the invention will be explained in more detail using an exemplary embodiment illustrated in the drawing, in which:

Figure 1 shows in schematic form a fitting head having two grippers in a V shape in relation to each other,

Figure 2 shows the fitting head according to figure 1 in a different working phase,

Figure 3 shows in schematic form a side view of another fitting head with grippers arranged in the manner of a turret, and

Figure 4 shows an end view of the fitting head according to figure 3.

According to figure 1, a fitting head 1 can be moved in the direction of the indicated arrows X and Y in two coordinate directions by means of a positioning system (not illustrated), for example between feed devices and a substrate. Feed devices of this type have, for example, mutually parallel component tapes 2 having pockets in which electronic components 3 are accommodated. By means of stepwise displacement of the component tape 2, the pockets can be displaced into a fetch position, in which the respective component 3 can be removed from the component tape 2 in the indicated vertical arrow direction by a gripper 4, for example by means of suction.

The gripper 4 is guided in a pivoting part 5 and can be displaced in the fetch direction, perpendicular to the plane of movement. It is lowered with its holding end onto the component, which is lying in a ready position and arrives in the active range of a suction channel of the gripper. By means of withdrawing the gripper, the component 3 is removed from the component tape and lifted into the transport position illustrated.

The pivoting part 5 can be pivoted about a horizontal axis 6 in accordance with the circular arrow S. It has a second gripper 4, which is arranged in a V-shape with respect to the other gripper 4 in the pivoting plane of the pivoting part 5, in such a way that the longitudinal axes of the grippers 4 meet at the center of the axis 6.

In addition, the fitting head 1 has an annular storage element 7, which is concentric with the vertical gripper 4 and is provided with an annular sliding part 8, which is mounted on a stationary

annular part 9 of the storage element 7 such that it can be rotated in the direction of rotation arrow D. A free inner side of the

sliding part 9 is of conical design and provided with suction openings 10, which are arranged such that they run around at uniform pitch spacings. These suction openings 10 define storage spaces 11 for the components 3.

The pivoting part 5 can be pivoted between stops 12 belonging to the fitting head 1 in such a way that in each case one of the grippers 4 is located in the vertical fetch position, and the other gripper is located in an oblique transfer position, in which it is assigned to a transfer station 19 of the fitting head 1. At the same time, the sliding part 8 is rotated into a position in which it is assigned to one of the free storage spaces 11, likewise belonging to the transfer station 19, the gripper 4 being oriented perpendicular to the storage space 11. By means of a vertical placement movement of the gripper 4, the previously fetched component 3 can be deposited on the storage space 11 of the sliding part 8. During these transfer operations, the pressure relationships in the suction opening 10 and the suction channel of the gripper 4 can be controlled in such a way that the component 3 is held securely in every phase and can be transferred without being offset laterally.

By means of pivoting the pivoting part 5, the free gripper 4 can then be pivoted into the fetch position, the other gripper 4 moving into a different transfer position, in which it is assigned to a further transfer station 19, which is located diametrically opposite the other. The sliding part 8 is cycled in such a way that in each case one of the storage spaces 11 is located in the transfer station 19, the storage element 7 already having been completely filled after half a revolution of the sliding part 8.

Then, according to figure 2, the fitting head 1 can be moved in a fitting area of the fitting apparatus above a substrate 13, onto which the component 3, in a movement sequence which is the reverse of that for

filling, are removed successively from the storage element 7 and placed onto the substrate 13.

According to figures 3 and 4, a large number of grippers 14 is arranged on a rotor 15, which is mounted on a stator 16 of another fitting head 17 such that it can be rotated step by step. Various angular positions of the grippers 14 are associated with different working stations. These are, for example, constructed as a placement station 18, a transfer station 19, a sensing station 20 and a rotating station 21.

In the placement station 18, the components 3 are removed from the component tape 2 and, in two steps, are pivoted as far as the transfer station. Located at their level is the annular storage element 7 having the conical sliding part 8, on whose storage spaces 11 the components 3 can successively be placed. After these locations have been filled, the grippers 14 of the rotor 15 can be populated with additional components 3 in a further cycle, those components which are less suitable for intermediate storage in the storage element 7 being those considered in particular.

The fitting head 17 then moves until it is above the substrate 13 to be fitted, into the position shown in figure 4. Here, first of all the components 3 located on the grippers 14 are placed onto the substrate 13 in the placement station 18. During this cycle, the precise position of the components 3 is determined in the optical sensing station 20. In the following rotation station 21, the angular position of the components 3 is corrected by rotating the gripper 14 about its longitudinal axis, which is arranged such that it is vertically radial with respect to the axis of rotation of the rotor.

As soon as grippers 14 which have become free reach the transfer station 19, they successively remove the components 3 from the synchronously corotating sliding part 8 of the gripper 7 and, after passing through the sensing station 20 and rotation station 21, likewise place said components onto the substrate 13. After all the components 3 have been placed onto the

substrate 13,

the fitting head 17 can be moved over the feed devices for a new fetch cycle.

It is possible to provide, in the fitting head 17, at least one further storage element 7 and one further transfer station, as indicated dash-dotted in figure 4. By this means, the storage capacity of the fitting head 17 can be increased appropriately.